Charge Sensitivity of a Radio-Frequency Single Electron Transistor Using Phase-Shift Detection

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The radio-frequency single-electron transistor (RF-SET) is the most sensitive detector of charge to date. Typically the RF-SETs display a charge resolution as the variation in reflected RF amplitude. In our experiment, we performed the phase-shift detection as well as amplitude detection, and studied the charge sensitivity as a function of various parameters such as SET bias voltage, RF frequency, RF power and magnetic field. We found that in certain range of SET bias voltage and RF frequency, the sensitivity using phase-shift detection (3.8×10^{-3} $e/(\mathrm{Hz})^{1/2}$) is better than that using amplitude detection. One may improve the charge sensitivity about two orders of magnitude by applying a cryogenic preamplifier so as to meet the requirement for quantum bit applications. The phase-shift detection can also be used in building a phase-locked loop to further improve the performance of RF-SET as a charge sensor. Finally, the possibility of combining the on-chip coplanar cavity and a SET for GHz operation frequency will be also addressed.

References

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